Chapter 2:
Matter and Change

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LAB 2.1: States of Matter

Objective:

Create a model for each of the 3 states of matter, using your powers of observation.

2

Solid: form of matter with a definite shape and definite volume

Liquid: form of matter with a definite volume but no definite shape-
it will take the shape of a container

Gas: a form of matter that has no definite shape and no definite volume

What is the difference between a vapor and a gas? Why "water vapor" not "water gas"?

Vapor: describes the gaseous state of a substance that is generally a liquid or a solid at room temperature

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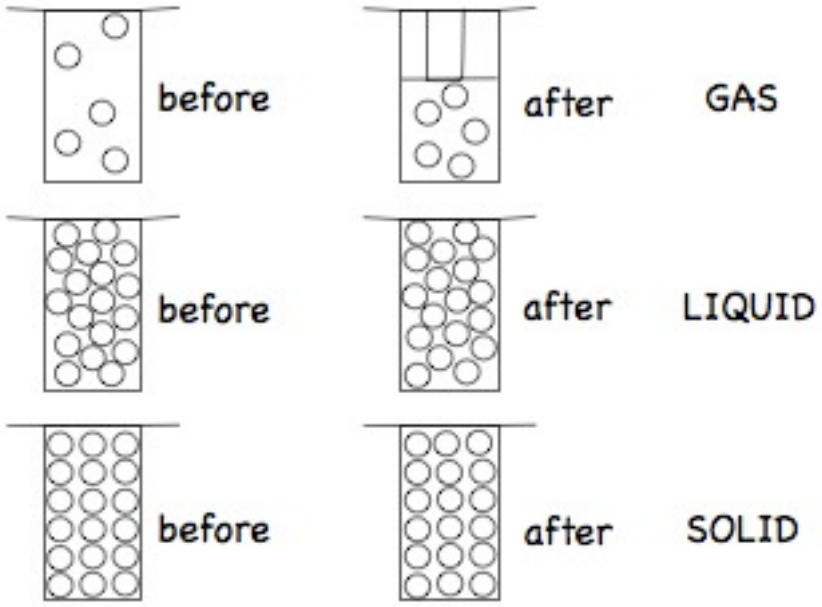

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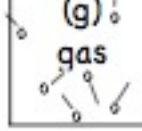
Use this chart to help remember these extensive properties

(s) solid 	definite shape	definite volume	almost incompressible
(l) liquid 	indef. shape	definite volume	almost incompressible
(g) gas 	indef. shape	indef. volume	easily compressible

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What about Oobleck? Or the "unknown substance?"

Both of these substances are polymers.

What is a polymer?

- a substance consisting of a long chain of molecules

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Lab 2.2: Chemical changes and the nature of matter

Objectives:

To identify when a chemical reaction takes place based on observations.

To record observations and interpretations using words and pictures.

To become familiar with how chemicals react.

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Physical vs. Chemical Changes

H_2O (liquid) $\xrightarrow{\text{heat}}$ H_2O (vapor)

reactant is same as product

the only change is a change in the state of matter

...this is a PHYSICAL CHANGE

H_2O (liquid) $\xrightarrow{\text{electricity}}$ H_2 (g) + O_2 (g)

reactant and products are not the same

...this is a CHEMICAL CHANGE

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Electrolysis of Water

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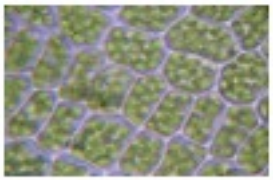
Examples of common chemical changes



Photosynthesis

$6CO_2 + 12H_2O \longrightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$

Oxidation (Rusting)

$6Fe + 3O_2 \Rightarrow 3Fe_2O_3$

Combustion (Burning)

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

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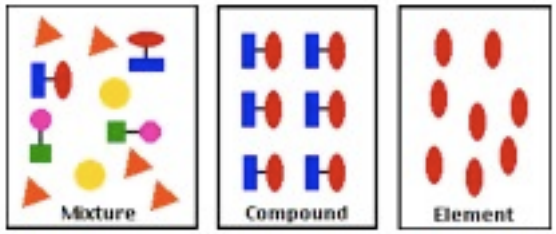

Mixture

$NaCl + H_2O$

Compound

$NaCl$

H_2O

Element

Na

Cl

H

O

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CLASSIFYING MIXTURES:

mixture: a physical blend of two or more components

There are two types of mixtures... heterogeneous and homogeneous mixtures

Hetero: not uniform composition

Homo: uniform composition
homogeneous mixtures are also called solutions

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Solutions can be solid, liquid, or gas! What is a solid solution?

Phase: a term used to describe any part of a sample that has uniform composition and properties

Example:

OIL	VINEGAR	OIL & VINEGAR
Homo	Homo	Hetero
1 phase	1 phase	2 phases

How many more days until winter break??
JUST KIDDING!!!

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Separating Mixtures

Filtration: used to separate by size

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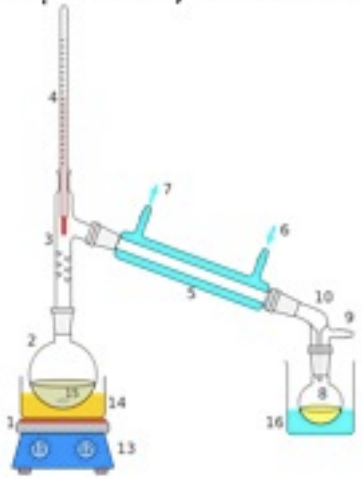
Distillation: copy and label the drawing of the distillation apparatus on p. 47 of your text. Explain in your notes how it works.

- Separation by temperature
- More specifically BOILING POINTS



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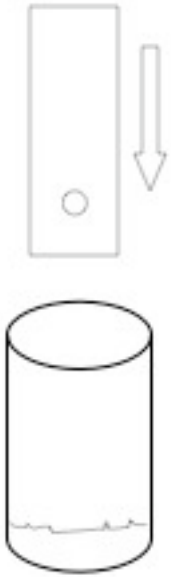
Chromatography

- Obtain Vial of H_2O and paper
- Insert Paper into vial
- Spot should NOT be below liquid level



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Chromatography

- Purpose

- Essential Components
  - Mixture
  - Stationary Phase
  - Mobile Phase

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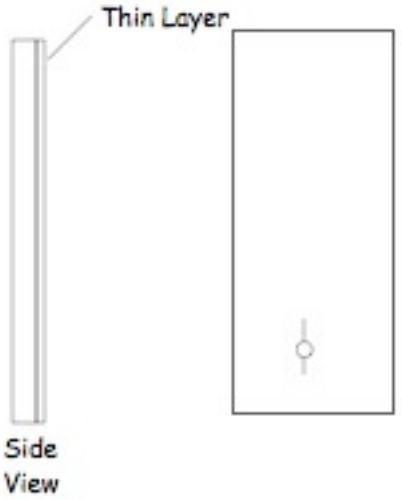
Thin Layer Chromatography (TLC)



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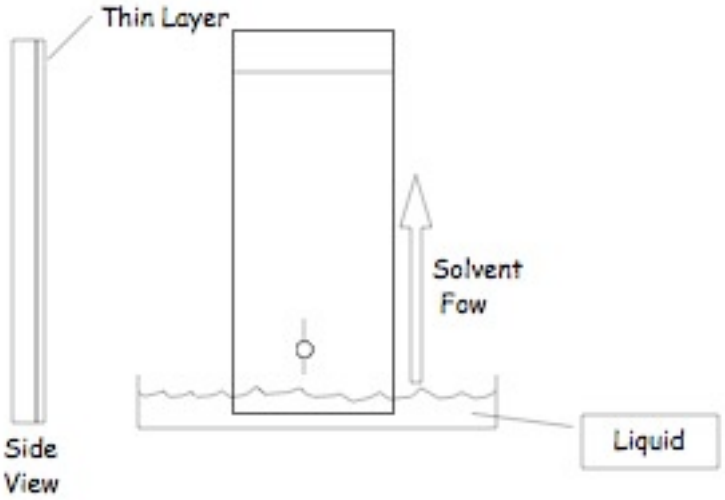
Thin Layer Chromatography (TLC)



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Applications of Thin Layer Chromatography in Forensics

- Inks from Pens
- Drugs
- Dyes (from fibers, etc.)
- Petroleum Products
- Explosives
- Etc.

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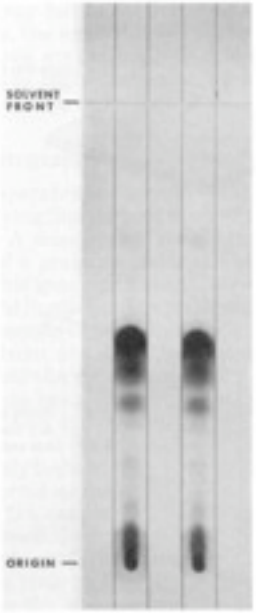
TLC Marijuana Extract

Each spot represents a component of the mixture



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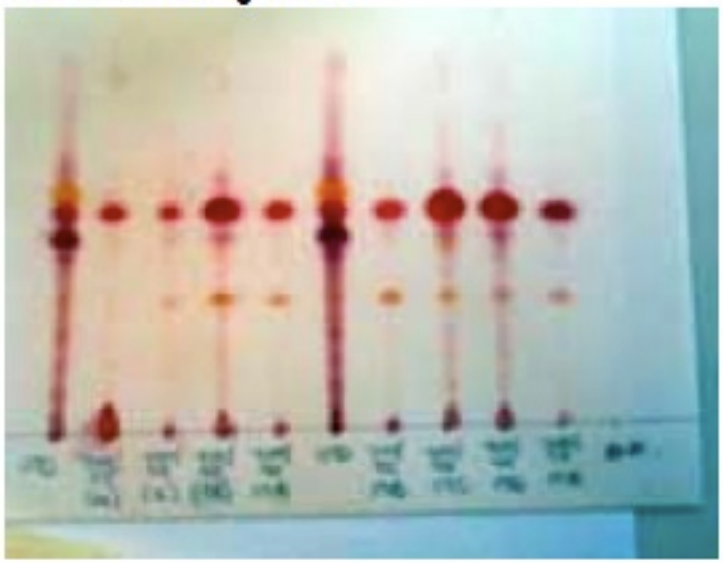
TLC of Marijuana



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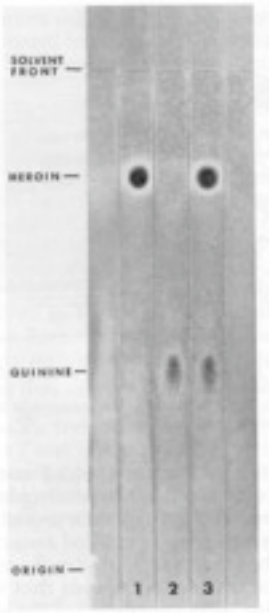
TLC of heroin sample

Lanes 1 and 2 are standards
- Lane 1 - Heroin
- Lane 2 - Quinine

Lane 3 is the sample

$$R_f = \frac{d_{component}}{d_{solvent}}$$



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Chromatography

- One phase is held in place (sometimes a solid) while another moves past it (often a liquid or a gas).
  - The phases cannot mix with one another
- Encompasses a collection of techniques to separate components of complex mixtures
  - Thin Layer Chromatography (TLC)
  - Liquid Chromatography (LC)
  - Gas Chromatography (GC)

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Theory of Chromatography

- Based on differences in the abilities of compounds to "adhere" to a stationary phase while being flushed through it with a mobile phase
  - Stationary phase (does not move)
  - Mobile phase (used to flush sample across SP)
  - The reason different molecules separate
    - Intermolecular Interactions
      - Dipole-dipole
      - Dispersion Forces

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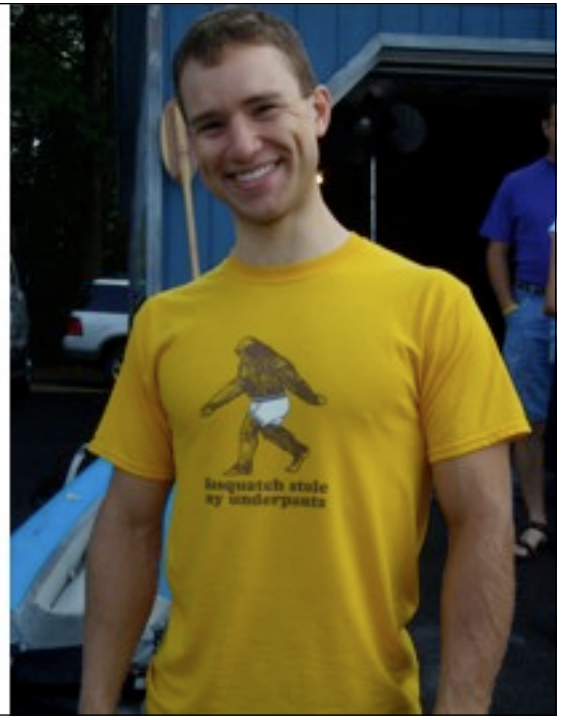
Properties of Matter

Extensive properties

depend on the amount of matter

Intensive properties

depends on the type of matter



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Gold – Extensive properties

Mass = 27 g

Volume = 1.4 ml

Mass = 1000 g

Volume = 51.8 ml

Intensive properties – can be looked up in a reference text.

Phase solid

Density (near r.t.) 19.3 g/ml

Liquid density at m.p. 17.31 g/ml

Melting point 1337.33 K (1064.18 °C, 1947.52 °F)

Boiling point 3129 K (2856 °C, 5173 °F)

Heat of fusion 12.55 kJ/mol

Heat of vaporization 324 kJ/mol

Specific heat capacity (25 °C) 25.418 J/mol/K

How do you calculate density?

mass/volume

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Sodium chloride (salt) – Extensive properties

mass = 2700 kg
(= 2,700,000 g)
volume = 1,250,000 ml

mass = 6.0 g

volume = 2.8 ml

Intensive Properties

Molecular formula NaCl
Molar mass 58.44277 g/mol
Appearance White or colorless crystals or powder
Density 2.16 g/cm³, solid
Melting point 801 °C
Boiling point 1465 °C (1738 K)
Solubility in water 35.9 g/100 mL (25 °C)

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Common physical changes

Evaporation of salt water leaving salt behind

Condensation of water vapor into liquid water (formation of dew)

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Hints for detecting CHEMICAL CHANGES

temperature change (heat released or absorbed)

light given off or absorbed

both indicate a transfer of energy

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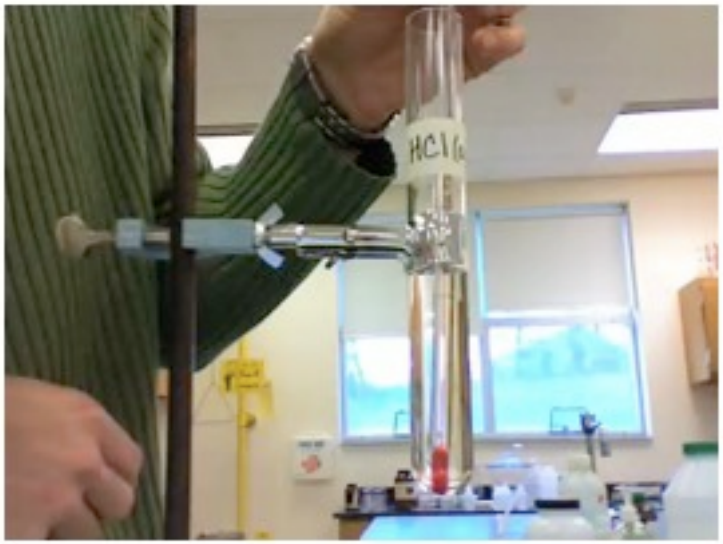
bubbles (gas given off)



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a solid settling out of a liquid (precipitate)

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color change

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In chemical reactions THE LAW OF CONSERVATION OF MASS applies.

What is this law?

Mass of reactants = Mass of products

What kinds of chemical reactions may be going on here?